Quantifying the accuracy of the Photon Libraries

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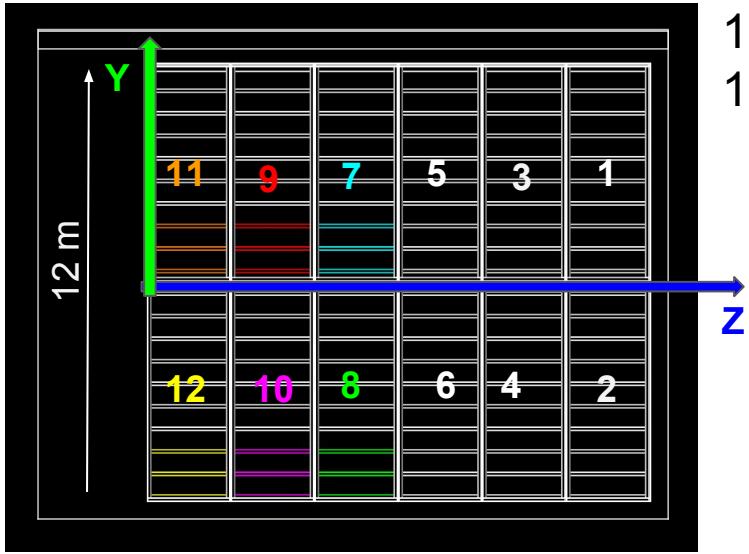
Motivation

- Optical transport has been implemented in LArSoft in two different ways:
  - fast and full mode

- Full mode: simulates photon propagation

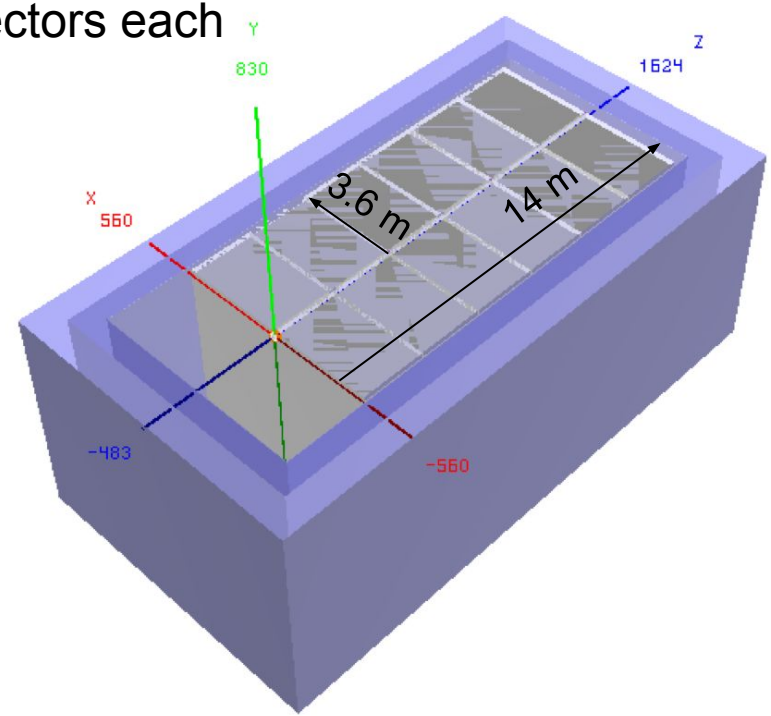
- Fast mode: is based on a lookup table (called photon library) specifying “visibility” of each position in the detector for each optical detector

Geometry: dune10kt_v1_1x2x6_nowires.gdml



Side view for x = 0

12 APAs with
10 Optical Detectors each

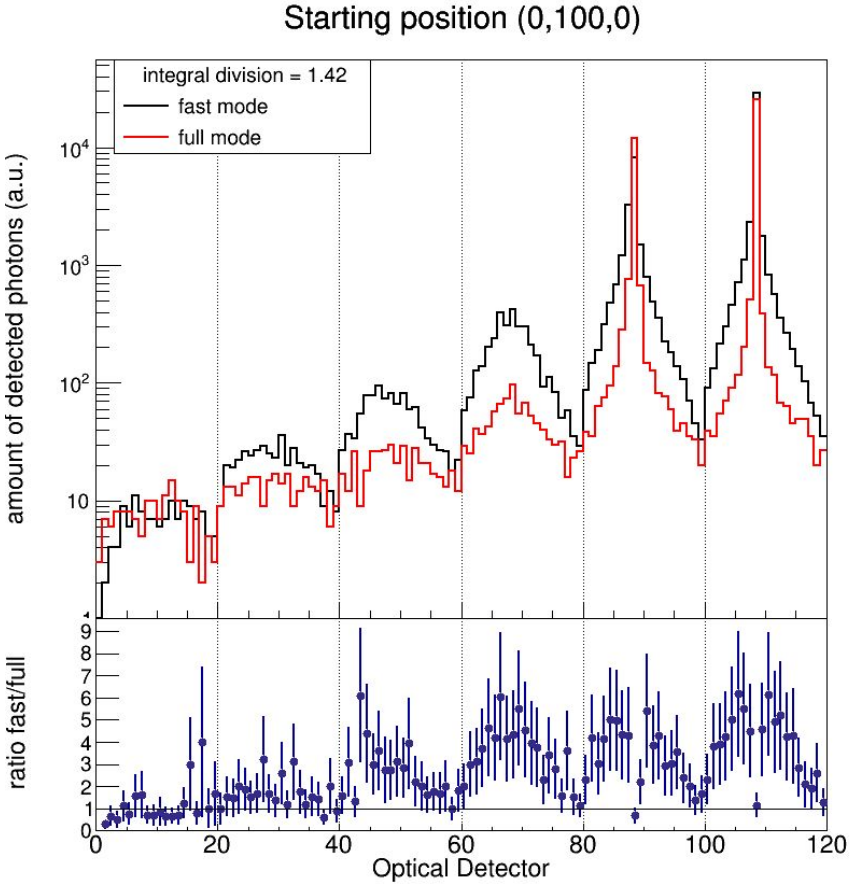


Top view for y = 0 of the detector's lower half

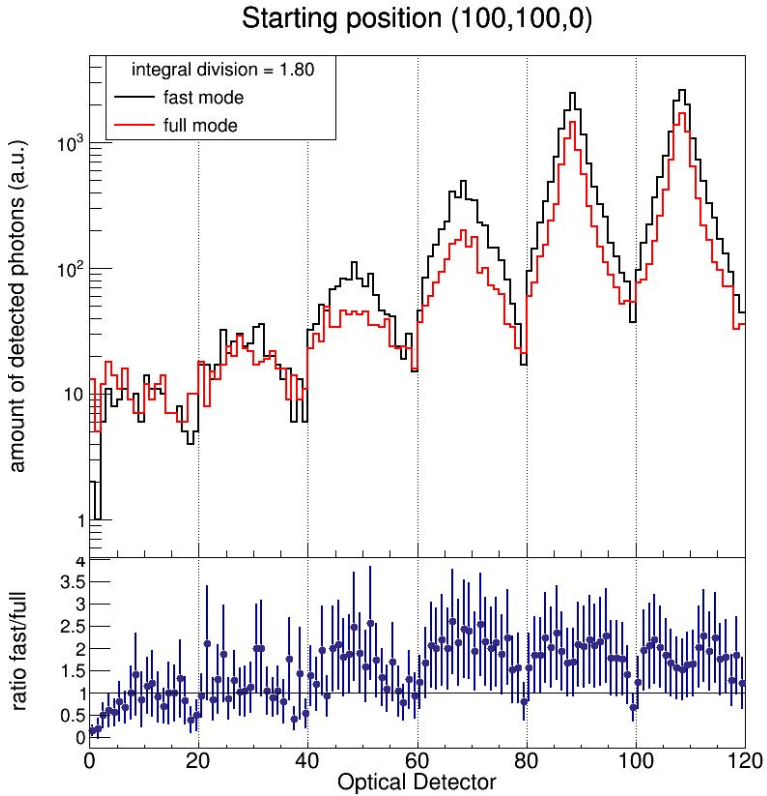
Using LArSoft v06_49_01

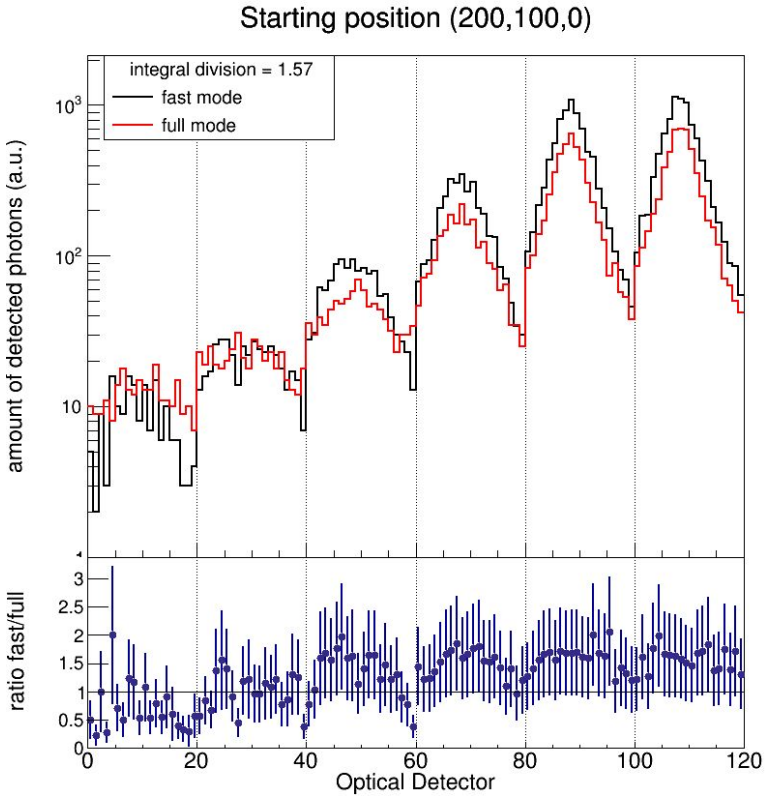
Comparison of amount of detected photons for fast vs full simulation mode

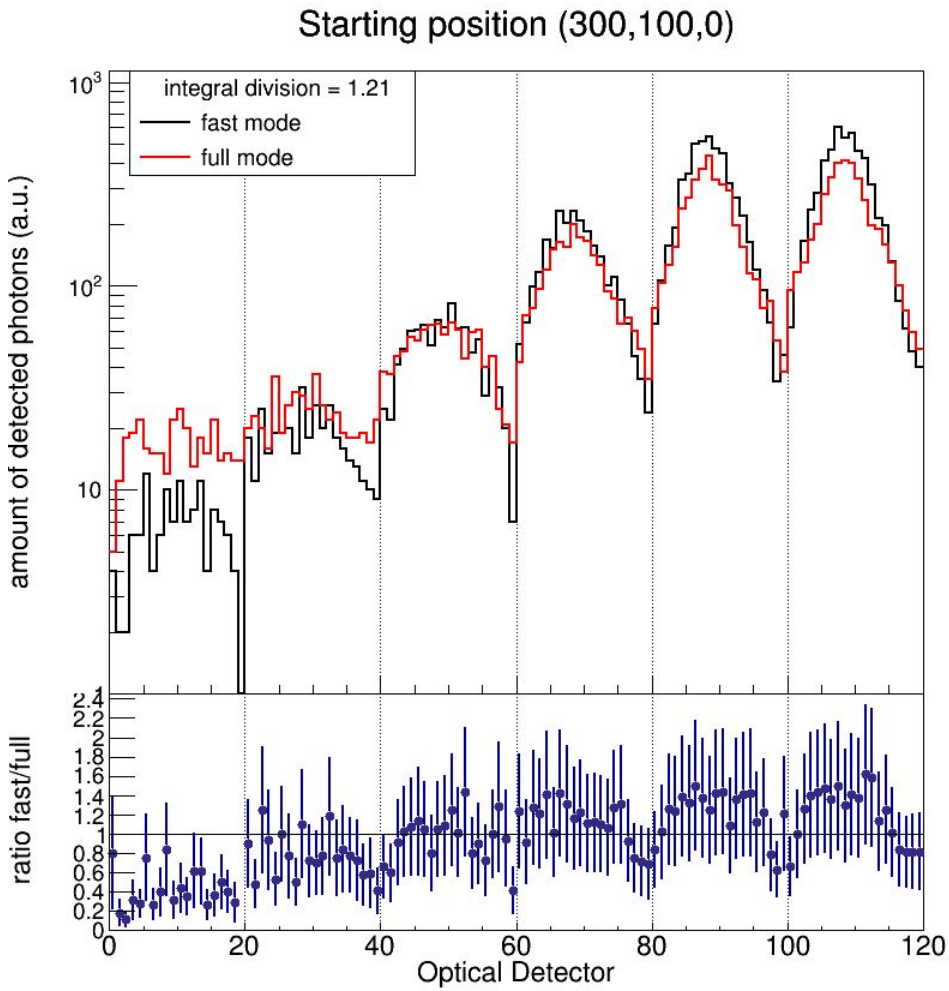
- 10 muons with 1GeV momentum in z-direction and initial position (0,100, 0) [cm]
- Compare total amount of detected photons per optical detector running fast mode vs full mode
- Data extracted from pmtresponse/OpDets tree generated by SimPhotonCounter_module.cc
- All muons have slightly different trajectories even with identical initial conditions



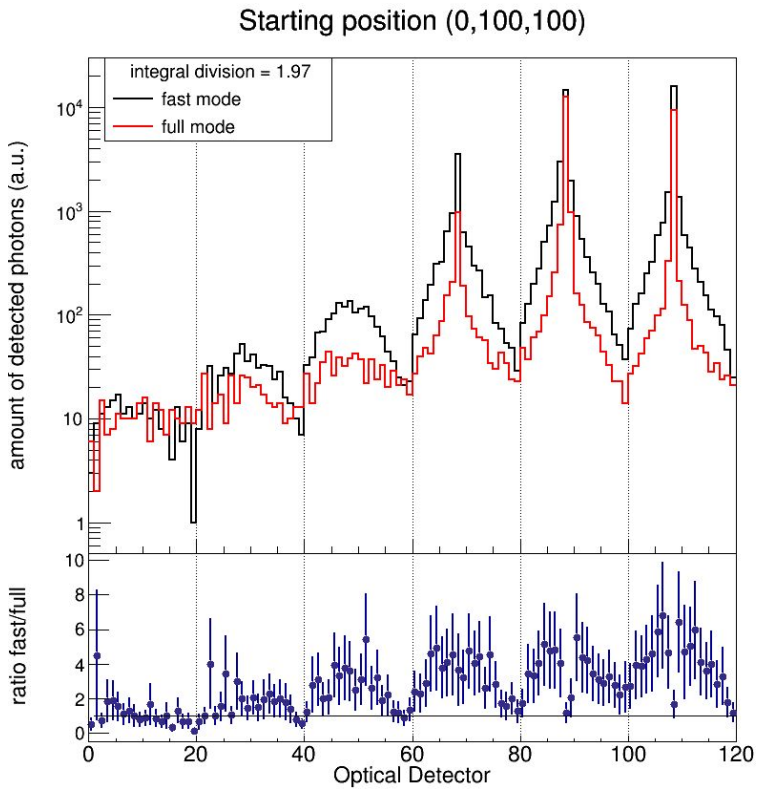
Fast vs full simulation mode for 10 muons with 1GeV momentum in z-direction starting position (x, 100, 0)

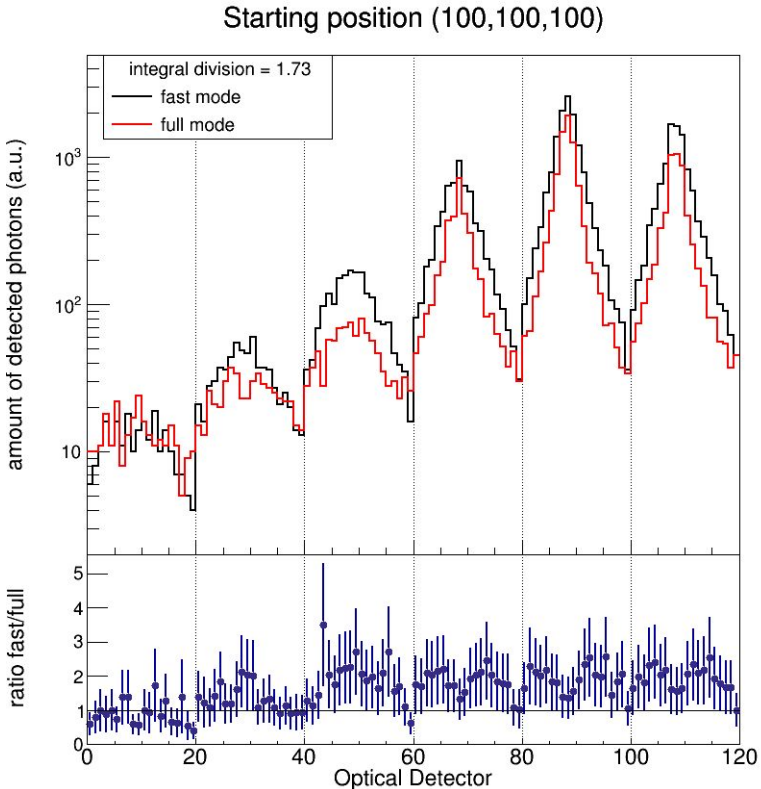


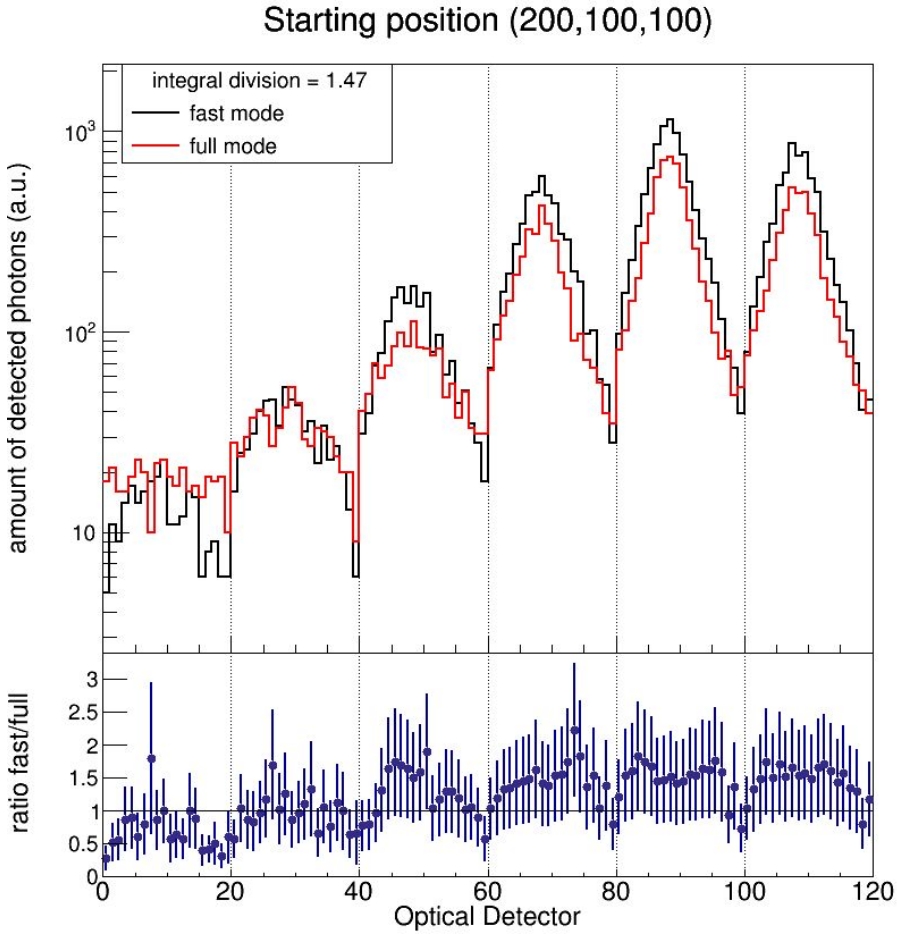


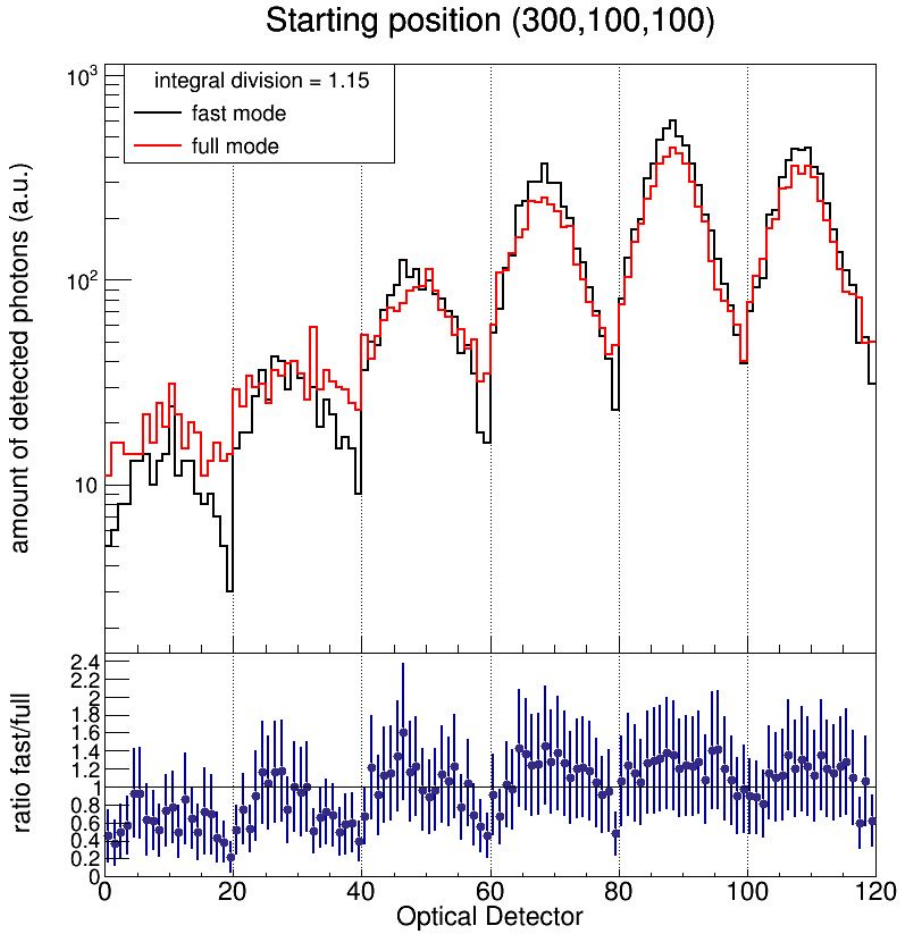

Starting position (300,100,0)
integral division = 1.21
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector

Fast vs full simulation mode for 10 muons with 1GeV momentum in z-direction starting position (x, 100, 100)

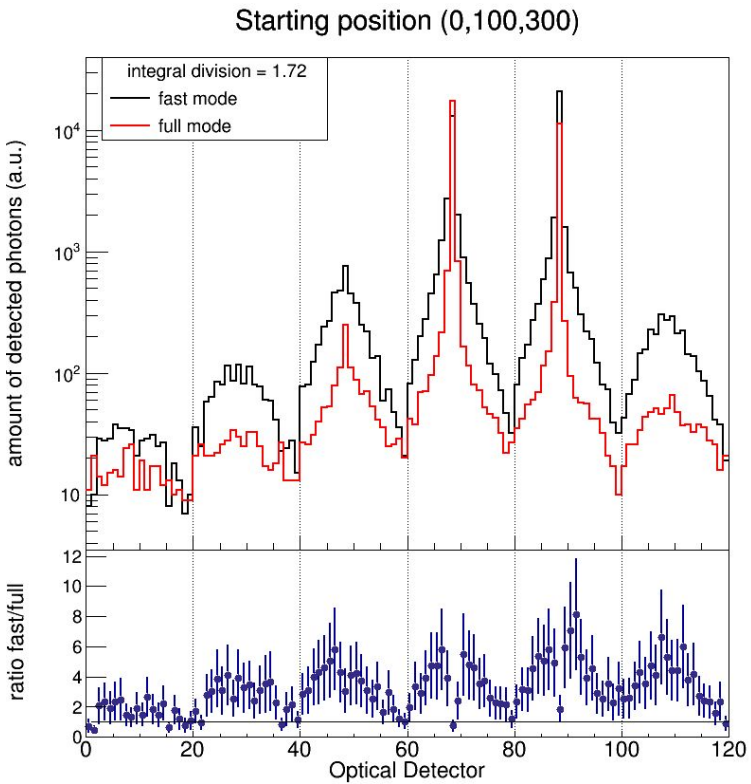


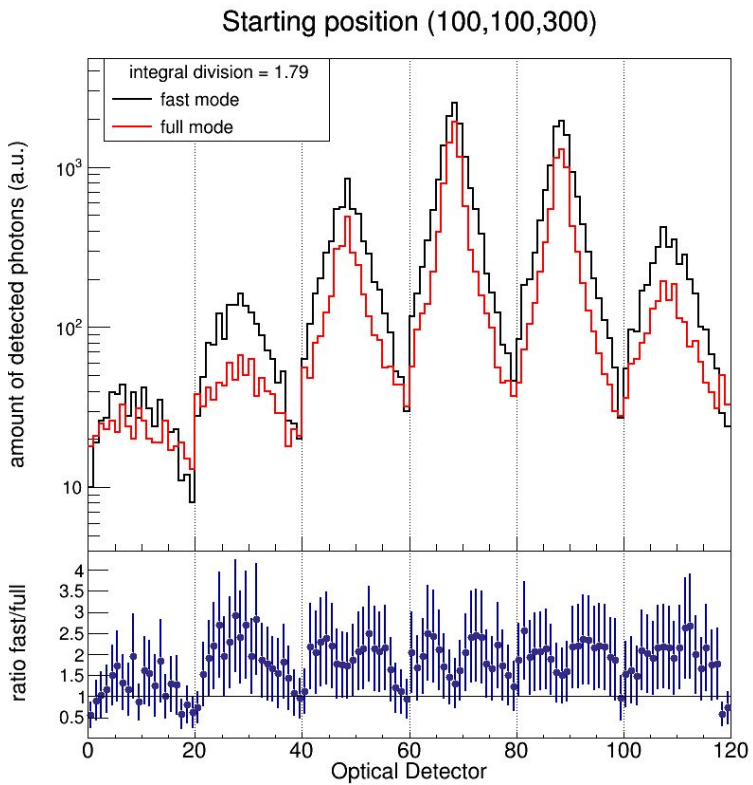


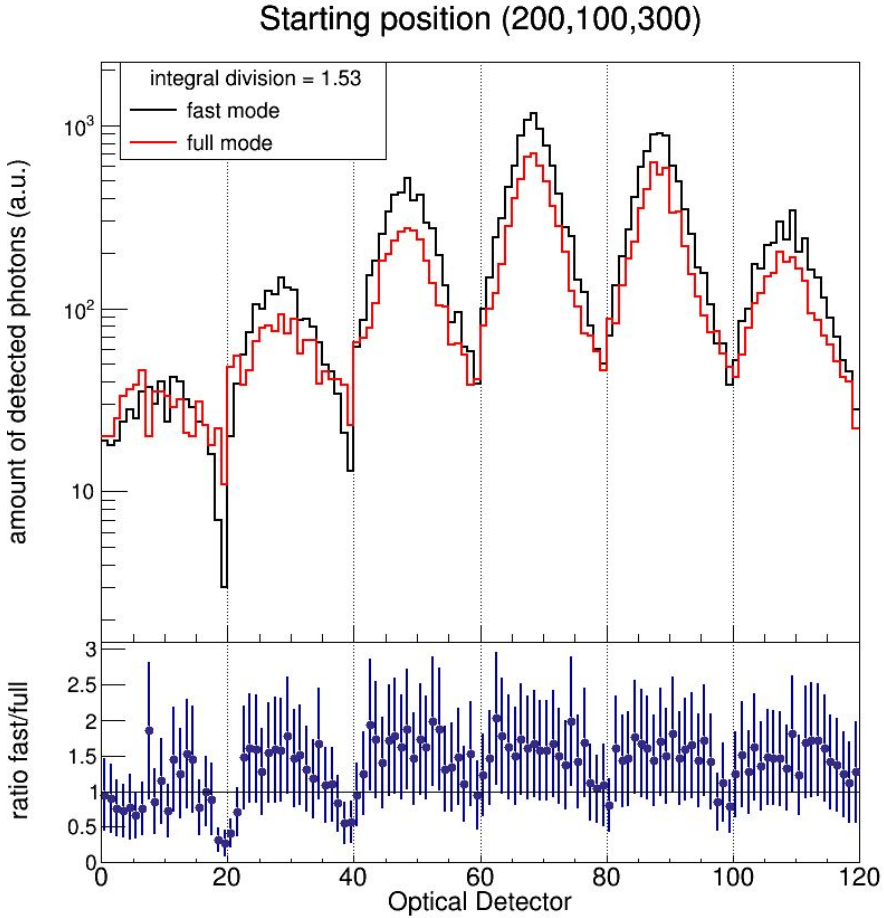

Starting position (200,100,100)
integral division = 1.47
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector

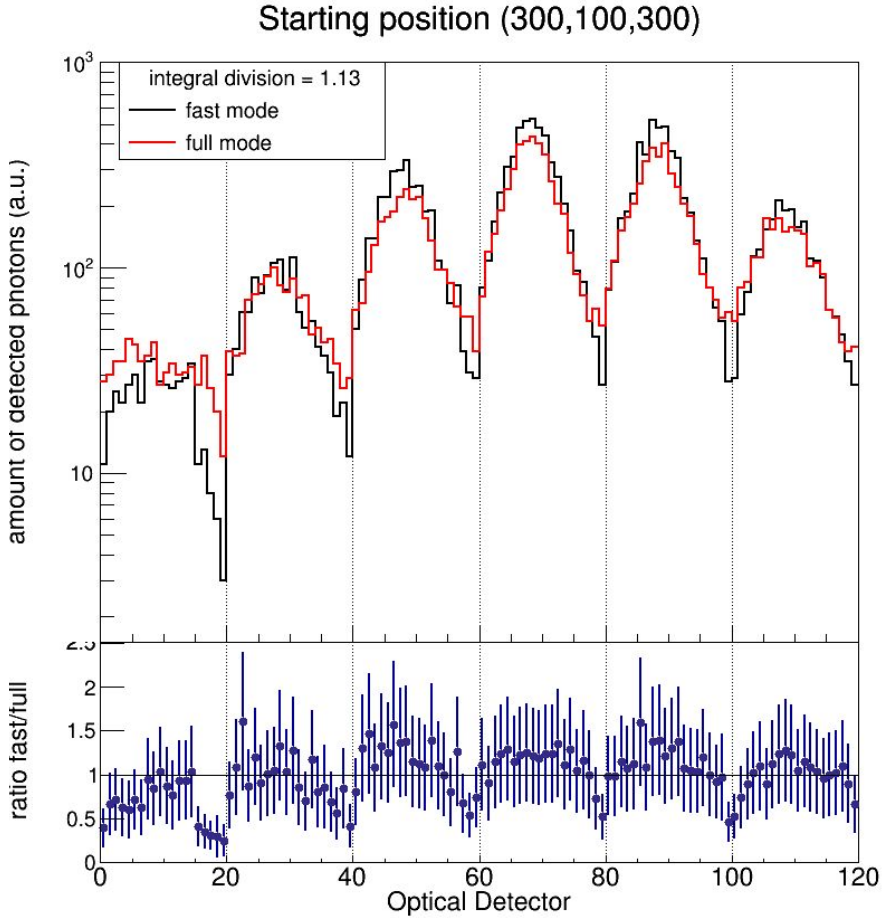

Starting position (300,100,100)
integral division = 1.15
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector

Fast vs full simulation mode for 10 muons with 1GeV momentum in z-direction starting position (x, 100, 300)

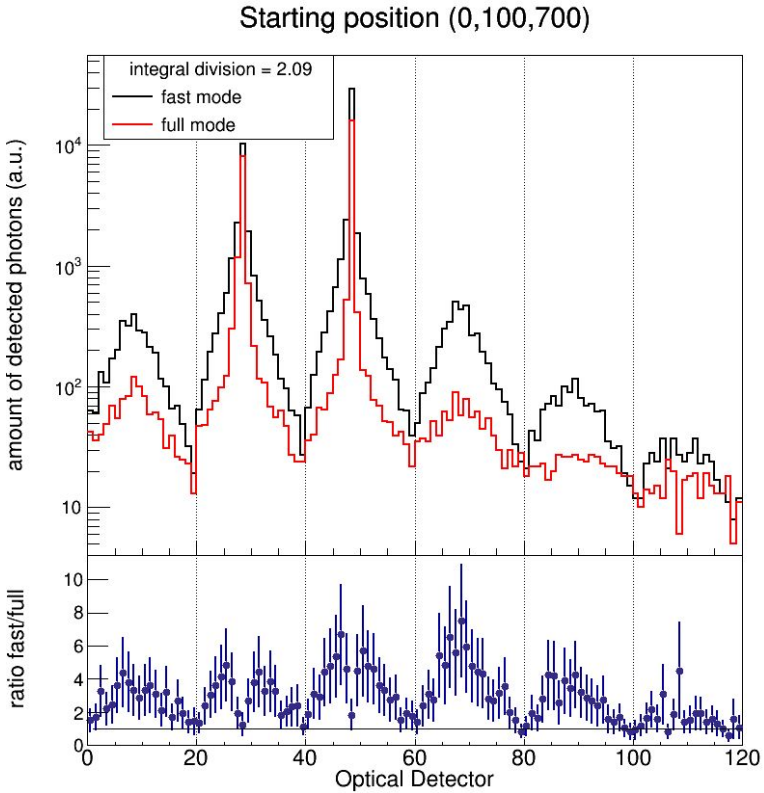


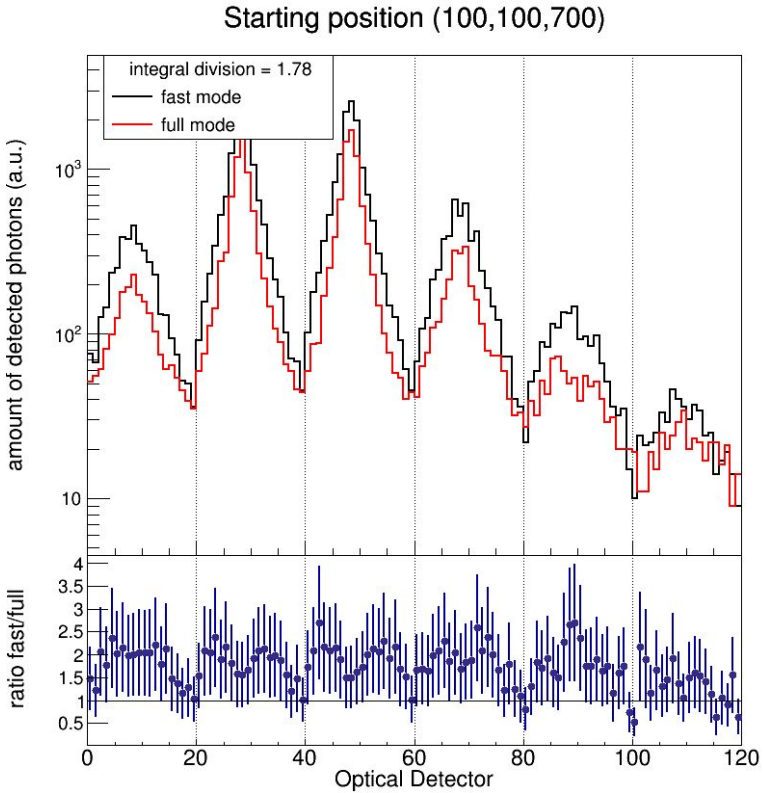


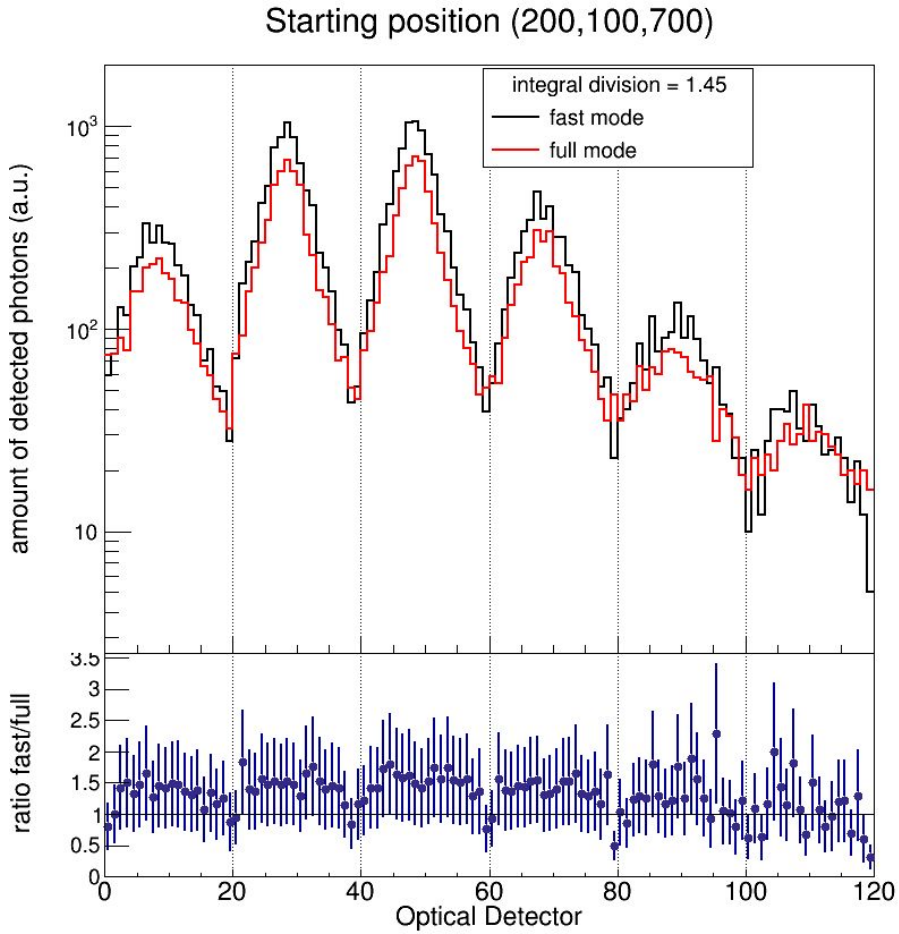

Starting position (200,100,300)
integral division = 1.53
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector

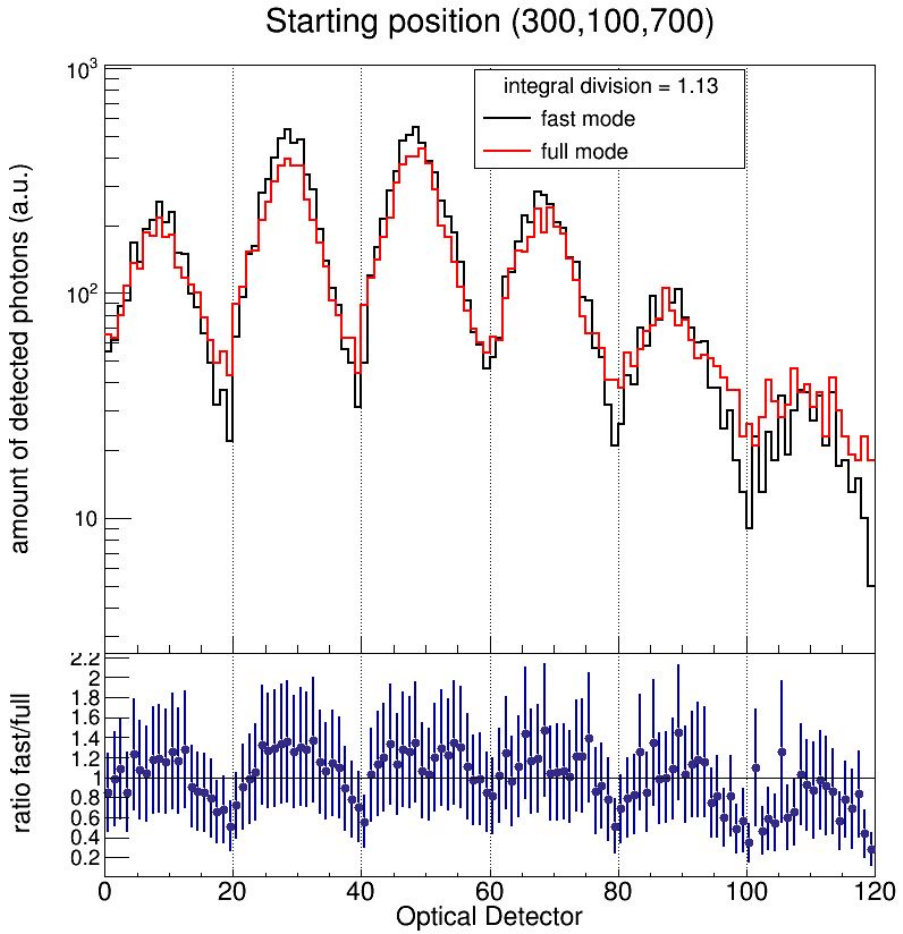

Starting position (300,100,300)
integral division = 1.13
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector

Fast vs full simulation mode for 10 muons with 1GeV momentum in z-direction starting position (x, 100, 700)

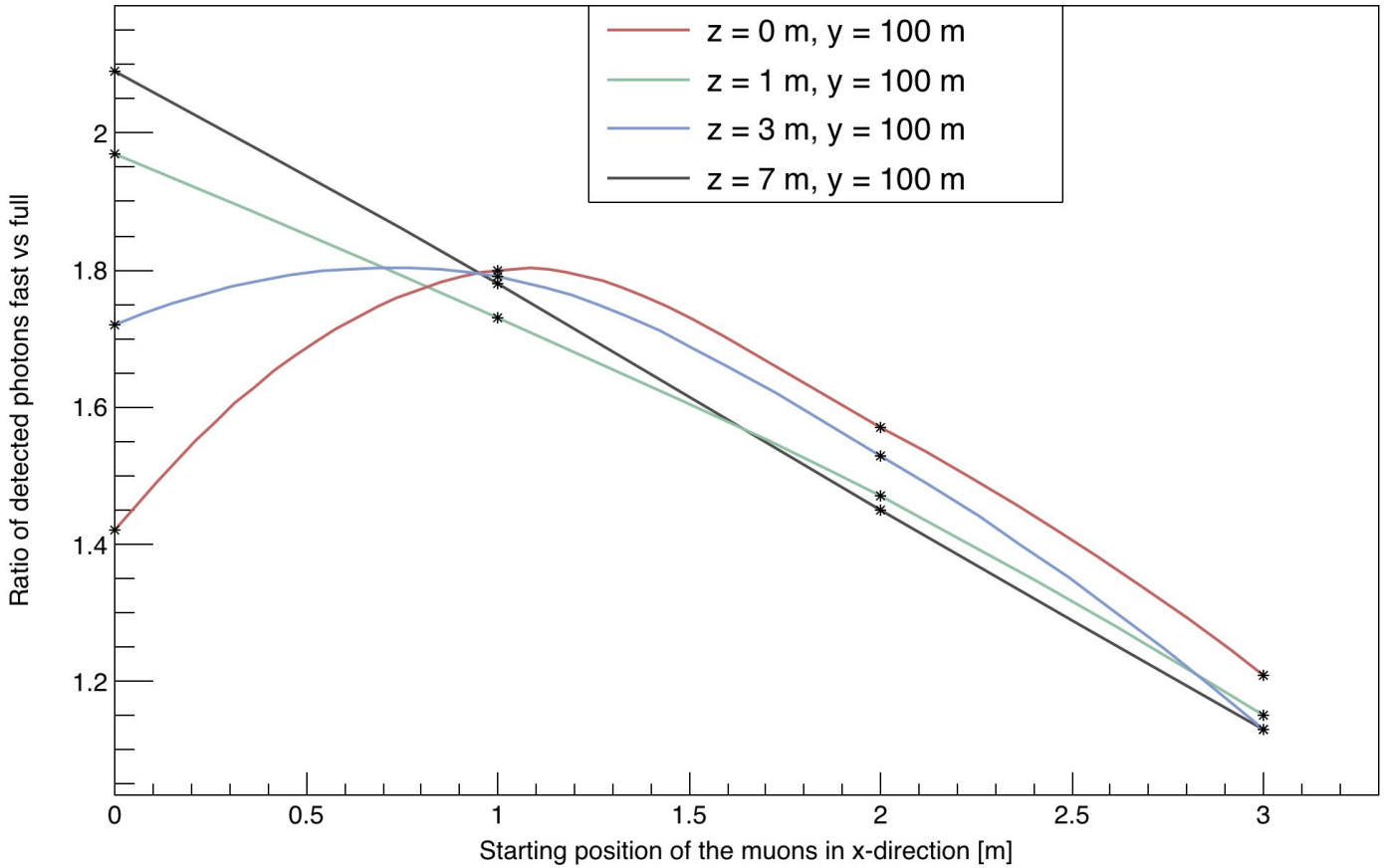





Starting position (200,100,700)
integral division = 1.45
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector


Starting position (300,100,700)
integral division = 1.13
fast mode
full mode
amount of detected photons (a.u.)
ratio fast/full
Optical Detector

Integral division for different starting positions



Conclusions and future work

- Difference between fast and full modes: the amount of detected photons is systematically higher in fast mode
- Difference is smallest for muons' starting position closer to the cathode
- Redo this analysis comparing the output of identical trajectories for the muons:
  - running the fast and full simulation modes in parallel
  - fixing the random seeds in Geant4

Thank you for all the help! Especially to Alex Himmel and Jason Stock!